Research Article

Determining priorities in functional rehabilitation related to quality of life one-year following a traumatic spinal cord injury

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Context/Objective: To determine the relationship between the different functional aspects (as determined by the Spinal Cord Independence Measure) and quality of life (QOL) following a traumatic spinal cord injury (TSCI), considering clinical confounding factors.
Design: Retrospective review of a prospective cohort
Setting: A single Level-1 trauma center specialized in SCI care
Participants: One hundred and forty-two individuals sustaining an acute traumatic SCI
Interventions: Not applicable
Outcome measures: The four QOL domains as assessed by the WHOQoL-bref questionnaire 6–12 months following a TSCI.
Results: Mobility subscore was the only functional aspect significantly associated with all QOL domains (physical, psychological, social and environmental). Females present better chronic social and environmental QOL when compared to males. The level of injury may also influence environmental QOL.
Conclusion: Mobility training (mobility in bed, mobility with or without technical aids, transfers and stair management) should be an important part of the rehabilitation process in order to optimize chronic QOL following a TSCI.

Keywords: Spinal cord injury, Mobility, Quality of life, Function, Trauma

Introduction

Traumatic spinal cord injuries (TSCI) lead to severe functional limitations and secondary complications affecting physical, emotional and social areas of health.[1] A comprehensive evaluation of the outcomes following TSCI thus requires considering quality of life (QOL), in order to improve the management of patients using a holistic approach with the ultimate goal of reaching the highest functional status possible. The rehabilitation process is a critical part of the coping process following such a severe injury, and comprises multidisciplinary therapies throughout the continuum care encompassing various functional aspects (self-care, respiratory and sphincter management, as well as mobility training).

Previous studies have shown that functional outcome may influence directly and/or indirectly QOL following TSCI. A meta-analysis by Dijkers[2] reported moderate correlations between functional impairment and QOL,[2,3] while Erosa *et al.*[4] showed that greater functional impairment was predictive for decreased participation, which is an important aspect of QOL.[4] Unfortunately, these studies did not identify which specific functional aspects mainly influence QOL and should be prioritized during functional rehabilitation. As a result, there is still no consensus on how the different aspects of functional training should be prioritized during rehabilitation following TSCI.

This study aims at identifying which specific functional aspects should be prioritized during rehabilitation

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in order to optimize QOL following a TSCI. Accordingly, we will investigate the relationships between different functional aspects determined by the third version of the Spinal Cord Independence Measure (SCIM) and QOL evaluated using the WHOQOL-bref instrument.

Methods

Patients

A prospective cohort of 142 patients consecutively admitted to a single Level I SCI-specialized trauma center between March 2011 and October 2016 (113 males and 29 females; mean age ± SD: 48.5 ± 18.7 years old) for a TSCI was studied. Patients entered the cohort at the time of admission after consent and were followed until discharge from the acute SCI-center. They were included if they sustained an acute cervical (C1–C8) or thoraco-lumbar (T1–L1) TSCI requiring surgical management at our institution; were aged 16 years and older; and presented at their follow-up visit in the chronic phase between 6 and 12 months after the TSCI. Patients were excluded if they sustained a penetrating trauma, did not attend follow-up visits, or failed to complete the QOL or functional assessments. The study was approved by the institutional review board and all patients were enrolled on a voluntary basis.

Data collection

Socio-demographic, clinical and trauma information were collected prospectively and updated on a daily basis during the acute care hospitalization. Socio-demographic data included age, sex, household income (<40,000$; 40,000–100,000$; >100,000$), employment status at the time of the injury (active worker vs. unemployed/retired/student), education level (less than college vs. college or more) and people living in the household/marital status (alone vs. married/common-law vs. living with family member other than spouse). The body mass index (BMI) was also calculated. The burden of comorbidities was also assessed using the Charlson Comorbidity Index, which weighs comorbidities based on the adjusted relative risk of one-year mortality.[5]

The initial severity of the TSCI was assessed upon arrival to the SCI-center within 72 hours of the TSCI and was reported using the American Spinal Injury Association (ASIA) impairment scale (AIS) grade (A to D) as well as the initial ASIA motor score. The neurological level of injury was stratified as high (C1-C4) or low tetraplegia (C5-C8), and high (T1-T7) or low paraplegia (T8-L1). Trauma severity was assessed from the Injury Severity Score (ISS),[6] the presence of concomitant traumatic brain injury (none vs. mild vs. moderate vs. severe) as well as the presence of central cord syndrome. The mechanism of injury (sports vs. assault-blunt vs. fall vs. transport vs. other) and trauma velocity (high vs. low) were noted. Surgical delay, defined as the time (in hours) between the injury and the time of incision, was also considered. Hospital length of stay was defined as the number of days from admission to discharge from the acute SCI-center.

The third version of the SCIM was used to assess functional status after the TSCI. The SCIM is a valid and reliable disability scale specifically aimed at assessing the ability of SCI patients to perform daily living activities independently.[7] The SCIM includes three domains: self-care (six items evaluating feeding, grooming, bathing and dressing); respiration and sphincter management (four items); and mobility and transfers (nine items evaluating bed, indoor and outdoor mobility).[7] The score for self-care ranges between 0 and 20, while respiration/sphincter management and mobility/transfers scores both range between 0 and 40. The total SCIM score thus varies between 0 and 100, with a higher score corresponding to a higher functional status.

Outcome assessment

QOL was quantified from four domains assessed using the WHOQoL-Bref instrument, which has been validated for the SCI population.[8] The WHOQOL-Bref instrument consists of 24 items assessing four distinct health domains: (1) physical health (7 items); (2) psychological health (6 items); (3) social relationships (3 items) and (4) environment (8 items). Higher scores correspond to higher health-related QOL. Both WHOQOL-Bref instrument and SCIM were administered at the routine follow-up visit during the chronic phase between 6 and 12 months after the TSCI.

Statistical analyses

Statistical analyses were performed using the IBM SPSS Statistics Version 19 software package. Continuous and categorical variables were presented as mean ± standard deviation and percentages, respectively. Multivariable linear regression analyses (general linear model) were used to evaluate the strength of association between each domain of the WHOQOL-Bref questionnaire (dependent variable) and the independent variables. The three domain subscores and total score of the SCIM were defined as the main independent variables, while the socio-demographic data, characteristics of the injury, surgical delay and acute care length of stay

were considered as covariates. A backward elimination method was used to obtain the final regression model. The strength of association was expressed in terms of beta (β) coefficients with corresponding 95% confidence interval (CI), and the percentage of the variance explained by each model was assessed from the $R2$ coefficient.

Results

The socio-demographic, trauma and clinical information for the cohort of 142 patients are presented in Table 1. The final regression model for each WHOQOL-bref domain is shown in Table 2. A total of 23 independent variables/covariates were included in each regression model. The SCIM mobility subscore was the only functional aspect significantly associated with all QOL domains when considering covariates. More specifically, a higher SCIM mobility subscore was the only significant factor associated with higher physical and psychological scores, explaining 6% and 18% of total variance for each model. Higher scores on the SCIM mobility subscore predicted higher scores on the social aspect of the WHOQOL-Bref instrument, while lower social scores were associated with males. The environmental score was significantly higher with higher SCIM mobility subscore, female sex, increased ISS and more caudal neurological level of injury. All final models were significant ($P < 10^{-3}$) and the models describing social and environmental QOL explained 13% and 24% of the total variance.

Discussion

Reaching optimal QOL after a TSCI is a priority for individuals with severe deficits and limitations. The rehabilitation phase is therefore critical to provide the training and knowledge required to maximize functional recovery and QOL. Even if the importance of rehabilitation training is well recognized,[9] the impact of specific functional training on QOL following TSCI remains uncertain. To our knowledge, this is the first study evaluating the relationship between specific functional abilities and QOL following a TSCI, while considering various confounding variables using multivariable analyses.

The results suggest that improved mobility is significantly associated with higher QOL scores for all domains of the WHOQOL-Bref instrument (physical, psychological, social and environmental) during the chronic phase after TSCI. Mobility in the SCIM questionnaire refers to the ability to mobilize in bed, as

Table 1 Baseline characteristics of the total cohort of patients with traumatic spinal cord injury ($N = 142$).

Socio-demographic	Age	Mean ± SD	48.5 ± 18.7
	Sex	% Male	79.6
	Household income	% 0–40,000$	18.3
		% 40,000–100,000$	35.2
		% >100,000$	12.7
		% Unknown/ refused to answer	33.8
	Employment status	% Active worker	58.5
		% Unemployed, student, or retired	39.4
		% Unknown/ refused to answer	2.1
	Education level	% Less than college	61.3
		% More than college	31.7
		% Unknown/ refused to answer	7.0
	Marital status	% Living alone	21.1
		% Spouse/ Partner	52.8
		% Family member or other	23.9
		% Unknown/ refused to answer	2.1
	Charlson Comorbidity Index (CCI)	% 0	87.3
		% 1	7.0
		% 2	4.9
		% 3	0.0
		% 4	0.0
		% 5	0.0
		% 6	0.7
	Body Mass Index (BMI)	Mean ± SD	26.6 ± 7.6
Initial trauma	AIS grade	% A	38.7
		% B	9.2
		% C	13.4
		% D	38.7
	Neurological level of injury (NLI)	% C1–C4	38.0
		% C5–C8	29.6
		% T1–T7	7.7
		% T8–L1	24.6
	Mechanism of injury	% Sports	16.2
		% Assault-blunt	7.0
		% Fall	43.0
		% Transport	31.0
		% Other	2.8
	High velocity trauma	% High	56.3
		% Low	35.9
		% Unknown	7.7
	Injury Severity Scale (ISS)	Mean ± SD	23.1 ± 8.3
	Severity of concomitant traumatic brain injury (TBI)	% No TBI	48.6
		% Mild	48.6
		% Moderate	2.1
		% Severe	0.7
	Central cord syndrome (%)		23.2
Clinical evolution	Surgical timing (hours)	Mean ± SD	103.1 ± 374.0
	Length of stay in acute care (days)	Mean ± SD	24.6 ± 14.3

AIS = ASIA (American Spinal Injury Association) Impairment Scale.

Table 2 Results of the multivariate regression analyses using General Lineal Models (GLM) for each of the WHOQOL-Bref domains (physical, psychological, social and environmental) ($N = 142$).

Dependent variables for each final GLM	Significant variable(s) in the final model	Beta (95%CI)	R^2 value of the final model	Final model P value
Model 1: Physical	SCIM_mobility	0.23 (0.08–0.37)	0.062	0.003
Model 2: Psychological	SCIM_mobility	0.46 (0.26–0.67)	0.123	$<10^{-3}$
Model 3: Social	SCIM_mobility	0.52 (0.27–0.76)	0.128	$<10^{-3}$
	Male	−8.19 (−15.83–0.55)		
Model 4: Environmental	SCIM_mobility	0.58 (0.35–0.80)	0.240	$<10^{-3}$
	Male	−8.75 (−15.26—2.25)		
	Level of injury	9.16 (2.37–15.95)		
	C0–C4	10.41 (3.30–17.52)		
	C5–C8	13.27 (2.39–24.16)		
	T1–T7	reference category		
	T8–L1			
	ISS	0.40 (0.06–0.75)		

ISS, injury severity score; SCIM, Spinal Cord Independence Measure.

well as move on various distances, indoor or outdoor, with or without technical aids or wheelchair.[7] It also determines to the ability to manage stairs and transfers in various situations.[7] Individuals with TSCI generally experience severe limitations in mobility due to muscular weakness/paralysis, as well as spasticity, balance disorders, joint contractures and pain.[9,10] Part of mobility training, therefore, consists in optimizing these factors, while working with technical aids and specialized equipment when applicable (such as robotic technologies and locomotor training).[10,11] Improved mobility was shown to represent a priority after a TSCI,[12] and an important predictor of participation.[4] For instance, mobility restrictions limit the ability to live independently, return to work and participate in previous leisure activities. Low mobility is also associated with weaker social engagement, which impairs psychological well-being and ultimately impedes fulfillment of the social role as well as a sense of identity.[13] In comparison with other functional aspect (self-care, respiratory and sphincter management), adequate mobility training may, therefore, improve the social limitations related to TSCI. To that extent, interventions promoting social reintegration should be integrated early during the rehabilitation phase.[4,14]

QOL is a broad concept involving several personal attributes, adaptability, personal perception and values[15,16] that were not considered in this study. Accordingly, the percentage of variance (R^2) observed for the regression models were modest (Table 2). Therefore, the severity of functional impairments can only be considered as one of many predictors of QOL following TSCI.[3] However, our results remain invaluable because identifying specific functional ability independently associated to QOL can guide the rehabilitation process and resources utilization. Keeping in mind that the rehabilitation process should be adapted to a multidisciplinary holistic approach, this study suggests that mobility training is key and should be initiated as early as possible. While early improved mobility can prevent medical complications,[17] it can also facilitate further gains in mobility throughout the subsequent phases of the rehabilitation process.[9] Identifying specific functional aspects associated with QOL is particularly important because there is still no consensus on the optimal acute rehabilitation plan to follow after a TSCI, despite the substantial costs and resources required during the rehabilitation process. However, future multi-centric studies are needed to establish evidence-based guidelines supporting our findings.

The multivariable regression analyses also suggest that most of the collected baseline characteristics (Table 1) were not associated with physical and psychological QOL, which is in accordance with previous studies.[3,4] This result is surprising as social and environmental QOL domains depend on interpersonal relationships and interactions with the environment (social support, sexual activity, home environment, opportunities to acquire new skills and accessibility).[8] We have found that males were more likely to experience decreased social and environmental QOL. However, previous studies showed conflicting results for QOL in males and females, and different explanations have been proposed.[18–20] Biological factors (genes, hormones, etc.),[19] factors stemming from women''s social role (social network and support, non-paid work at home, etc.) and mixed factors such

as health-related lifestyles and mental health disorders can also contribute to the differences between males and females.[21] To that extent, we have performed additional comparative analyses between males and females, showing that males were less educated then women (P = .02). Education and mental development are recognized as important attributes of improved QOL, since it may empower a person, help being more proactive and gain control on life.[22,23] It should be however be underlined that education was not an independent predictive factor of QOL in our regression analyses, suggesting that the impact of education on QOL is potentially more important in males. Previous studies have also shown similar results in the SCI population.[24,25]

Limitations

A recognized limitation of this study is the relatively low percentage of variance (6–24%) of QOL explained by the regression models, although we have observed significant predictors of QOL among descriptors of the functional status. Indeed, regression models of QOL are typically associated with low R^2 values because about 50% of the variance is explained by the interpretation of qualitative QOL measures in people with disabilities.[26] In addition, factors other than those considered in the current study can also influence QOL. For instance, the functional status prior to the injury, social functioning and various psychological factors can influence chronic QOL following TSCI.[3,27] Presence of neurogenic pain[4] and employment status after the injury may also influence QOL. Future studies should, therefore, consider these factors and their interactions with participation and QOL. Nevertheless, this study assessed important predictors of QOL as reported in healthy individuals: sex, marital status, age, education level and disability.[28]

The presence of similar items between the SCIM and WHOQol-Bref instrument can also affect the results, leading to overestimation of the strength of association between specific functional aspects and QOL domains. For example, the presence of QOL items related to mobility in the WHOQol-Bref instrument (questions 15 and 25) could partially explain the significant association with the mobility subscore on the SCIM. However, this is not likely to be a major limitation since mobility was associated with all QOL domains, although questions 15 and 25 of the WHOQol-Bref instrument are not used to compute the psychological and social domain scores.

Conclusions

TSCI is associated with severe deficits and significant functional impairments. Optimizing long-term QOL is therefore critical following TSCI. In the current study, we have evaluated the relationships between the different functional abilities and QOL. The results have shown that mobility was the only functional aspect significantly associated with each of the four domains of the WHOQOL-bref instrument (physical, psychological, social and environmental). Mobility training should thus be prioritized during the rehabilitation phase following a TSCI in order to optimize the chronic QOL.

Abbreviations

TSCI: traumatic spinal cord injury
QOL: quality of life

Disclaimer statements

Contributors None.

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Declaration of interest None.

Conflicts of interest The authors report no conflicts of interest.

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